2018, Budapest, Hungary

H-SPACE 2018

4th INTERNATIONAL CONFERENCE ON RESEARCH, TECHNOLOGY AND EDUCATION OF SPACE

H-SPACE 2018

organized by Federated Innovation and Knowledge Centre of Budapest University of Technology and Economics and Hungarian Astronautical Society

H-SPACE 2018

Edited by László Bacsárdi and Kálmán Kovács

Magyar Asztronautikai Társaság

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Editors
László Bacsárdi and Kálmán Kovács

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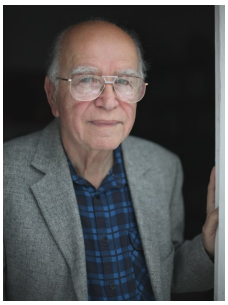
WELCOME

Iván Almár
Honorary President of Hungarian Astronautical Society, member of International Academy of Astronautics



This year we will celebrate the 50th anniversary of the first international space conference organized by the UN, "UNISPACE 1". I had the privilege to participate as member of the Hungarian delegation. It was a unique experience to meet colleagues from small and developing countries, who wanted to join the space community, emphasizing that space „is the common heritage of mankind". And what is the situation now, 50 years later?

It would be an easy task to mention examples of cooperation among far away countries in space research, utilization and development. I selected only one. We remember that in 2017 several strong hurricanes hit with unprecedented force in Texas and on the islands of the Antilles and the Caribbean. Hurricanes Harvey, Irma and Maria left behind a disaster and helpless, devastated countries. It was a real help that the International Charter on Space and Major Disasters (accepted in 2000) was activated immediately and 16 member agencies delivered space imagery of the disaster zones free of charge as quickly as possible. More than 20 satellites were in action to help people in trouble. My opinion is that this was a model how the „common heritage" should be interpreted nowadays.

András Pócza
Head of Department, Department for ICT Regulation and Management Ministry of National Development

Dear Participants,
Space has become an everyday part of our world. It is not only the domain of a few countries and academic inquiry anymore. Space is now a primary driver of research, technology, science, business, culture and societal development.
In the era of the Fourth Industrial Revolution, it is global cooperation, increasingly innovative business solutions, privatization and disruptive innovation that shape research, exploration, commercial exploitation and the societal utilization of space.
Hungary, a country with established space traditions, a vast technological and scientific heritage and a long-standing commitment to the world's space endeavors, embraces innovation and progress.
Hungarian space research and development started in the 1950's with active participation in the Interkosmos program. Since then, Hungary has also participated in numerous international space missions and projects.
A founding member of the UN Committee on the Peaceful Uses of Outer Space and a member of the European Union as well as the European Space Agency, Hungary has a wide range of space competences, ranging from satellite development and material sciences to medical sciences, remote sensing and earth observation.
As the world enters a new era of space exploration, Hungary continues to contribute to the research, exploration and utilization of space. While the world today faces global issues, space offers solutions for science, business, research and technology to cope with the challenges of the 21st century and pave the way for the future.

WELCOME from the Organizing Committee

We are happy to welcome you at the 4th International Conference on Research, Technology and Education of Space. Special welcome to those participants who join the H-SPACE conference for the first time.

The event is organized by the Federated Innovation and Knowledge Centre (EIT), within the Faculty of Electrical Engineering and Informatics at the Budapest University of Technology and Economics (BME) – in cooperation with the Hungarian Astronautical Society (MANT), which is the oldest space association in Hungary. The organization of the conference series started in 2015, at a time of growing opportunities arising from ESA recently granting membership to Hungary and the need for a joint presentation of space activities pursued at BME. The selection of the date of the event pays tribute to the successful deployment to orbit and mission of the first Hungarian satellite, the Masat-1, which has been launched on February 13, 2012.

The topic of this year's conference is "Space research for society on every scale". The agenda of the conference addresses scientific, technological and educational issues of space research and space activities. The conference is open for both local and international professionals and provides an opportunity to showcase Hungarian scientific, technological, educational and outreach activities, related to space.

The Organizing Committee has internationally recognized members: Prof. József Ádám, Dr. Tibor Bálint, Ferenc Horvai, Prof. János Lichtenberger, Dr. Lóránt Földváry, Prof. László Pap, Prof. Gábor Stépán, Dr. Szabolcs Rózsa. We are grateful for their contributions to the success of the conference.

The conference will have four main sections: Science and Technology I-III and Education and Outreach. Following the success of last year's poster session, we will organize a poster session with 12 great presentation.

The best lectures (oral or poster) will receive the option of publishing in a journal, thus the conference contributes to the scientific progress of the researchers as a publication opportunity.

This book contains the abstracts of the presentations. In the coming months, selected full papers will be published in the official conference proceedings which will be available on our website, space.bme.hu/hspace2018

We hope you will enjoy your time in Budapest and the H-SPACE conference could help to learn about new scientific and technological results and strengthen your network.

Kálmán Kovács
chair
Director of EIT BME

László Bacsárdi
co-chair
Secretary General of MANT

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Web: http://space.bme.hu/hspace2018

Conference Program
In this program, the affiliation of the first author is listed.

FEBRUARY 15, THURSDAY

14:00-14:20 Opening

János Józsa, Rector of Budapest University of Technology and Economics (BME)
András Pócza, Hungarian Space Office, Ministry of National Development
János Solymosi, President of Hungarian Astronautical Society

14:20-15:20 Long talks, Section of Science and Technology I

Estimation of Clear Sky Level for Satellite Propagation Measurements
Bernard Adjei-Frimpong, László Csurgai-Horvath
Department of Broadband Infocommunications and Electromagnetic Theory, BME, Hungary

Participating in NASA-ESA Cassini Mission at Wigner RCP, former KFKI RMKI
Pál Gábor Vizi, Károly Szegő, Sándor Szalai, János Nagy
MTA Wigner Research Centre for Physics, Hungary

Opportunities of 3D printing in the emerging field of Space Chemistry
Dorottya Milánkovich, Ferenc Darvas
Innostudio Inc., Hungary

15:20-15:40 One minute madness

Analyzing deformation above gas reservoir using multi-temporal InSAR
Bence Ambrus, Szabolcs Rózsa
Department of Geodesy and Surveying, BME, Hungary

Analyzing the Effects of Atmospheric Factors in Earth-space and Space-Earth Quantum Communication Channels
András Kiss, László Bacsárdi
Institute of Informatics and Economics, University of Sopron, Hungary

Citizen Science – An idea to integrate science into our digitized world
Péter Pusztai, Hungarian Astronautical Society, Hungary

Fifteen years in service for the society – the story of the Hungarian space web portal Űrvilág
Sándor Frey, László Bacsárdi
Űrvilág space portal, Hungary

Human Spaceflight: music effects in space confined environments
Luis Luque Alvarez
Széchenyi István University, Hungary

New methodologies for Big Data in space researches
Gergely Bencsik, Zoltán Pödör, László Bacsárdi
Institute of Informatics and Economics, University of Sopron, Hungary

Preparing a Lunar Rover Mission in the Framework of Ana log Planetary Research
Koppány Juhász, Mátyás Hazadi, Tibor Pacher, Miklós Pathy
PuliSpace Technologies Ltd., Hungary

Recent trends in light pollution measured from space in Hungary
Kornél Kolláth, Kai Pong Tong, Zoltán Kolláth
Hungarian Meteorological Service, Hungary

Sensors of Swarm Stream as Technology Research on Nano Scale
Pál Gábor Vizi
MTA Wigner Research Centre for Physics, Hungary

Sentinel-1 PSI Analysis of Greater Budapest Region
Péter Farkas, Gyula Grenerczy
Geo-Sentinel Ltd., Hungary

Simulation of different quantum error correction codes in free-space channels
Attila Iván, László Bacsárdi
Department of Networked Systems and Services, Hungary

Simulations of Single Event Effects in microelectronics caused by the lunar surface radiation environment
Dávid Lucsányi, Viktor Nagy, Vendel László, Miklós Pathy, Mátyás Hazadi
PuliSpace Technologies Ltd., Hungary

15:40-16:40 Poster session with coffee break

16:40-18:10 Technical presentations, Section of Science and Technology II

Optical transfer in space communication
Andrea Farkasvölgyi, István Frigyes
Department of Broadband Infocommunications and Electromagnetic Theory, BME, Hungary

Quantum Key Distribution in Space – A security review
Tamás Bisztray
Eötvös Loránd University, Hungary

Comparing Calculated and Measured Losses in QuESS's Quantum Channel
Máté Galambos, László Bacsárdi
Department of Networked Systems and Services, BME Hungary

Monitoring the movement of geodetic network in Thailand during 2013-2017 by GNSS
Nateepat Srivarom, Weng Jingnong, Serm Chinnarat
Beihang University, China

Tomographic Reconstruction of Atmospheric Water Vapour Using Simulated GNSS Data in Hungary
Yuxiang Yan, Wusheng Hu, Szabolcs Rózsa
Southeast University, China

Assessment of GNSS positioning under extreme weather conditions for safety-of-life application
Szabolcs Rózsa, Bence Ambrus, Ildikó Juni
Department of Geodesy and Surveying, BME, Hungary

FEBRUARY 16, FRIDAY

9:30-9:40 Opening of the second day
László Jakab
Dean of Faculty of Electrical Engineering and Informatics, BME
László Bacsárdi
Secretary General of Hungarian Astronautical Society

9:40-10:10 Keynote speaker
New perspectives in the Russian-Hungarian space connections
János Lichtenberger, Csaba Ferencz
Eötvös Loránd University, Hungary

10:10-11:00 Technical presentations, Section of Science and Technology III
Validation tests for the recently upgraded Thermo-Vacuum Chamber in the Laboratory of the Space Dosimetry Research Group
Anna Baranyai, Balázs Zábori, Attila Hirn
Centre for Energy Research, HAS, Hungary

Comparison of the predicted depressed state of crew mem bers with the results of their subjective psychological test at Concordia research station
Gábor Kiss, Klára Vicsi
Department of Telecommunications and Media Informatics, BME, Hungary

Activity of the ESA National Technology Transfer Office: Space technologies in everyday life
Zsuzsanna Tandi, Károly Szegő
MTA Wigner Research Centre for Physics, Hungary

11:00-11:20 Coffee break

11:20-12:35 Section of Education/Outreach

Expanding the Space of Space learning
Maria Messina, Giorgio Garagnani, Rosa Tagliamonte, Sabrina Ricci
Italian Space Agency, Italy

Hungarian Astro Pi experiments on the ISS
Flórián Vámosi, Péter Pósa
Mihály Táncsics Grammar School of Kaposvár, Hungary

Solar Physics in the high school - Study of the sunspots
Mária Pető
Székely Mikó High School, Romania

ESERO Romania: Using Space as a Gateway to STEM
Virgiliu Pop
Romanian Space Agency, Romania

Filling the Gap in the ESA Space Technology Education
Levente Dudás, András Gschwindt
Department of Broadband Infocommunications and Electromagnetic Theory, BME, Hungary

12:35 Closing remarks

Kálmán Kovács
Director of Federated Innovation and Knowledge Centre, BME

Table of Content

KEYNOTE

János Lichtenberger

János Lichtenberger currently works at the Department of Geophysics and Space Sciences, Eötvös Loránd University where he is the Head of the Space Research Group. He received his MSc in Physics in 1980 at Eötvös Loránd University, his PhD in 1996 and his Doctor of Hungarian Academy of Sciences distinction in 2011. He is member of the Scientific Council on Space Research of Hungary, and currently he is the chair of the Commission H of the International Union of Radio Science (URSI). Prof. Lichtenberger does research in Electromagnetism, Plasma Physics and Geophysics. His research interests are the following: Radio wave propagation in space plasmas; Space weather; Plasmasphere, magnetosphere, radiation belts; Satellite and ground based space experiments.

New perspectives in the Russian-Hungarian space connections

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propagation in space plasmas; Space weather; Plasmasphere, magnetosphere, radiation belts; Satellite and ground based space experiments.

The cooperation between Russia and Hungary in space has a long heritage, it started in the ‘60s in the frame of Intercosmos program. After a long low tide associated with the collapse of the Soviet Union, the cooperation has been revitalized recently. Beside industrial cooperation in space telecommunication and space dosimetry, development of three new wave experiments – various versions of SAS (Signal Analyzer and Sampler) instruments - has been started in 2017. The first instruments will fly on Chibis-AI microsatellite that continues the investigations of terrestrial lightning-related wave, optical and gamma-ray phenomena started by Chibis-M satellite. The Trabant mission aim is to study the space weather, the SAS3-T will continuously measure not only the six electromagnetic wave components, but uniquely transfers all the raw data to the ground. The Osbstanovka Phase-2 mission on International Space Station will extend the first Obstanovka experiment with three independent measuring buoys. Each buoys plus the central measuring points includes a SAS3 instrument. The four spatially separated measuring points allow us to measure the wavefront in the VLF range in the high density ionospheric plasma. This unique data set can be used to verify the basic plasma eqution s.

After a short historical review of Russian-Hungarian space connections, details will be given on the three new space missions,

Keywords:
wave instrument, space weather, ISS

Section of Science and Technology

Human Spaceflight: music effects in space confined environments

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Since Yuri Ggarin's journey to space and NASA's Apollo missions to the moon, listening to music in space has been very important for maintaining psychological and moral outcomes in astronauts. Starting with a "the wake up call", when a music sample is used to start the astronaut's day to astronauts listening their personal music collections and playing musical instruments on the International Space Station. Space agencies all over the world are planning exploration missions going either back to the Moon (with a possible human crewed lunar base) or on to Mars for the late 2020s. During such missions astronauts will experience confined environments without earth gravity, wind, ocean, family, smells, sounds, foods. Fortunately, humanity has a history of art, music and human culture which is a useful resource countermeasure for maintaining mental health. This raises a research question as could astronauts sleep, behave and work better if they listen to personal music during free time?.

The theory being that music could invoke the „Mozart Effect" stimulating the neurosensorial and psychological states to optimize cognitive processes consequently affecting sleep and work qualities. For the selection of special music samples it is therefore proposed to test musical intervention countermeasures according to the astronauts culture and personalities using Human Hypergravity Centrifuge Arm, Parabolic Flight Campaigns, Analog Space Simulation Environments such as Concordia Station, later on the International Space Station and/or during deep space missions considering a Lunar Crewed Base.

The experiments should be conducted with astronauts or astronauts candidates individually and collectively. Alternatively, if the target population is unavailable individuals working in the simulation environments that meet astronaut criteria would be used. Astronaut selection screening tools could be used to identify potentially relevant study participants. Studied results may

be used to: first during astronauts training period on Earth, create an „Astronaut Musical and Artistic Training Program", which should educate, induce and develop in astronauts basic artistic sensibilities and abilities for multicultural inclusion and instrumental practice, second, create a "Space Music Library (SML)", which should contain the best preselected music recordings for listening supporting astronauts according to psychological and physiological necessities, simple music sheets for collective and individual instrumental 2nd Symposium on Space Educational Activities, April 11-13, 2018, Budapest, Hungary practice in space and third, upgrade and adapt the sound hardware and musical instruments for different gravity environments and/or weightlessness.

The research previously proposed, seeks to offer through the history of music an artistic contribution to the positive maintenance of crew member's individual motivation, mental health and sociological behaviours.

Keywords:
Astronauts, Music, Behavior, Intervention, Education, Culture

References:
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3. Wigram, T., (2000). The Art and Science of Music Therapy: A Handbook. British Library
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5. Verrusio, W., et al. (2015). Mozart Effect and Its Clinical Applications: A Review. British
Journal of Medicine & Medical Research, 8(8): 639-650.

Analyzing deformation above gas reservoir using multi-temporal InSAR

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Space-borne radar techniques have started to see a new renaissance with ESA's Copernicus Earth observation program since the launch of the first Sentinel-1 satellite in 2014. The openly accessible data and the various software packages developed by ESA itself are giving rise to more and more instances of radar data being used for larger scale deformation analysis and monitoring with the help of the Interferometric SAR (InSAR) technique. Using its multi-temporal version (MT-InSAR), we are able to investigate deformation patterns that are markedly gradual and span over a longer period of time.
In this paper, a gas reservoir located in northern Germany (south of the city of Hamburg) is analyzed using the aforementioned technique and Sentinel-1 data. The continuous extraction and injection of gas into the reservoir and therefore the expansion and shrinkage of the storage have a significant effect on the ground layer above the reservoir. The aim of the project is to determine the signal of the ground deformation by using persistent scatterers located on the industrial site above the gas storage. Examining the movement of these persistent scatterers, we can indirectly draw conclusions about the pattern of the deformation that the underlying layers suffer due to the seasonal variation in the reservoir's contents.

Keywords: InSAR, PSInSAR, gas reservoir, Sentinel-1

References:
[1] Hanssen R. F, "Radar Interferometry – Data Interpretation and Error Analysis", Kluwer Academic Publishers, 2001
[2] Ferretti A. et al, "Permanent Scatterers in SAR Interferometry", IEEE Transactions on Geoscience and Remote Sensing, 39 (1)
[3] ESA Sentinel-1 webpage, http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/ Sentinel-1 (Last retrieved: Nov 17, 2017)

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Propagation measurement and data processing for Alphasat experiment in KA/Q band

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The European space agency lunched a communication satellite called 'Alphasat' in 2013, with two experimental beacon to also carry out scientific experiment and measurement at frequencies of 20GHz and 40GHz respectively. Propagation through the atmosphere at these frequencies are also affected by the presence of atmospheric particles like water vapour, water particles and ice drops. The atmospheric gases and rain, both absorb and scatter radio waves and consequently degrade their performance. Rain attenuation is the most significant parameter which degrades the performance of the links. Rain rate is the main parameter used to predict of rain attenuation. Rainfall statistical data are measured and recorded over integration time for the period in which data are collected. The prediction methods require minutes of integration time rain intensity.

In working to achieve this**,** we have set up a ground station at BME-HVT to carry out measurement in the Ka/Q band. The station receives signal from the satellite to characterize the Satellite -Earth propagation channel in the Ka/Q band. The beacon receiver station has been operating since 2014, collecting signal power data, and also records relevant meteorological data as well.

In this paper the processing procedures are discussed and exemplified by their application to the first year of measurements. In the first phase (data pre-processing), daily files of normalized duration are developed and a flag vector is generated. Received power in measured is converted attenuation following initial processing phases. The reference level attenuation is calculated on an event by- event basis in the first case. We also use the date to predict the first order attenuation statistics. We collect the data which has been analyzed and processed from received power to

* corresponding author

attenuation and predict the probability mean error. These will statistics for the clear sky level to be also evaluated over the one -year period.
The statistics obtained from these time series are compared with models predictions from the ITU-R to assess their usefulness and precision. The analyzed predicted attenuation statistics compared with ITUR measured rain attenuation, will provide useful estimation of rain fall attenuation in similar conditions for better characterization of the Ka/Q band.

Keywords: Propagation, data, statistics, attenuation, rainrate

References:
[1] Riera J.M. et. al.," Alphasat Propagation Experiment in Madrid: Quality Assessment of the Measurements", In Proc. 9th European Conference on Antennas and Propagation, Lisbon, Portugal, 12-17 April 2015.
[2] Rocha A. et. al., "Alphasat Q/V-band Propagation Campaign Preparation in Aveiro", In Proc. 9th European Conference on Antennas and Propagation, Lisbon, Portugal, 12-17 April 2015.
[3] Csurgai-Horváth L. et. al., "The Aldo Paraboni Scientific Experiment: Ka/Q Band Receiver Station in Hungary", In Proc. 9th European Conference on Antennas and Propagation, Lisbon, Portugal, 12-17 April 2015
[4] T. Rossi, M. De Sanctis, M. Ruggieri, C. Riva, L. Luini, G. Codispoti, E. Russo, G. Parca, "Satellite Communication and Propagation Experiments Through the Alphasat Q/V Band Aldo Paraboni Technology Demonstration Payload," IEEE Aerospace and Electronic Systems Magazine, 31(3), 18-27, March 2016 (DOI: 10.1109/T AES.2016.150220).
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Validation tests for the recently upgraded Thermo-Vacuum Chamber in the Laboratory of the Space Dosimetry Research Group

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It is clear that space environment is hazardous, so it is important to ensure the best performance of a product in space. It is necessary to conduct special tests on ground to verify that the devices can still operate properly in space. Two of the several specific properties which should be tested are the wide temperature range, and the vacuum. These can be controlled and monitored with a Thermal-Vacuum (T-VAC) Chamber, which is a prevalent equipment in space research. For the correct execution of the tests, it is crucial to know the maximum heating and the cooling velocity capability, and that how much time it takes to reach the thermal balance for chosen temperatures inside the chamber.

The T-VAC Chamber in the Laboratory of the Space Dosimetry Research Group was recently upgraded, so thermal-vacuum tests shall be performed to verify that the Thermo-Vacuum Chamber can operate in the range [-60°C; +95°C], at 5×10-4 Pa without installing test equipment and that all the ten Pt-103 Temperature Sensors operate within ±1°C accuracy. The vacuum is provided by a rotary and a turbomolecular pump. The execution of the temperature profile is provided by a LAUDA External Controller cooling/heating equipment. Thermal-vacuum cycling test was performed to determine the heating and cooling velocity of the LAUDA system. A thermal balance test was also performed to determine the accuracy of each of the Pt-103 Temperature Sensors.

* corresponding author

Keywords:
T-VAC chamber, velocity test, temperature balance test

References:
[1] European cooperation for Space Standardization, Space engineering, Testing, ECSS-E-ST-10-03C, Netherlands, 2012.

New methodologies for Big Data in space researches

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University of Sopron, Hungary

The classic research process includes several steps, like data collection, data storage, transformation, implementation of the analysis methods and presentation, visualization of the results. In many cases, each step is implemented in heterogeneous systems and therefore the connections between these systems can be difficult and not trivial task. Besides the four V's of Big Data, the volume, high velocity, the data variety as well as the veracity of the data contribute to complicate the basic problem [1]. Therefore, fully integrated solutions are developed and created, and this new integrated research processes are supported also by the Big Data and the Internet of Things environments [2]. These innovative approaches require new, appropriate algorithm adaptations, which are not sensitive of the data types, and fit in the integrating properties of the new research processes. Two self-developed methodologies are presented in this paper with the above-mentioned conditions.

The CReMIT (Cyclic Reverse Moving Interval Technique) method [3] extends the analysis possibilities of periodical time series—creating derived, secondary time series as dependent or independent variables—to find more precise correlations. Based on the given CReMIT parameters, a huge number of the derived time series can be created which are not depend on the further used analyzing methods. But based on our experiments, the linear and non-linear analyzing possibilities can cause such conditions near which the results are born just randomly, despite of the exact mathematical environment. To analyze and determine the random level of the given results, the Random Correlation method [4] was developed. The two methodologies are successfully applied in different scientific fields.

* corresponding author

Because of the data-independent property of our methods, they can be applied for the Space and Earth Observation research field as well. In this paper, by using the CReMIT method, we can extend the possibilities of analysis related to Space and Earth Observation researches, and in the same time, with Random Correlation, we can make the results more solid.

The research has been supported by the UNKP-17-4-III New National Excellence Program of the Ministry of Human Capacities.

Keywords:
Big Data in space, CReMIT, Random Correlations.

References:
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Quantum Key Distribution in Space – A security review

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The ability to securely transmit information is an essential requirement in the information age we are living in. With the rapid development of quantum computers, it is safe to assume that the way we send personal information will change in the near future. Quantum computer based algorithms are proven to break the current public key exchange methods that are used to establish a common secret between the communicating parties. Even if new classical algorithms are invented, there is no guarantee that the hard problem they are based on will be an obstacle for a strong computer or a better breaking algorithm in the future. A permanent solution for this problem is to turn to quantum physics namely, quantum key distribution (QKD). Here, instead of a hard mathematical problem, the security relies on the laws of physics [1].

In quantum key distribution, there are two different directions regarding the transmission channel. One is optical fiber based, the other is free space. The latter is further interesting since it opens up the possibility for satellite based quantum key distribution which can be the backbone of a global quantum encryption network [2].

As optical fiber based communication is restricted by the transmission distance because of fiber attenuation, in the space photons can propagate on long distances. This opens up the possibility to connect two geographically distant locations using quantum key distribution. To establish a satellite to ground link however proves to be a more challenging problem. In this paper we will discover the different technological approaches and some of the basic protocols that are used in free space communication.

The goal of QKD is to establish a common secret between two distant ground stations. By using satellites, the first challenge is to send the photons through the atmosphere. First, we are going

to examine the difference between downlink [3] and uplink [4] transmission and the limiting factors suchas absorption, scattering or weather conditions that can affect the success rate of a QKD.

Next we are examining the different approaches on how the information can be transmitted. The two main directions are the prepare and measure and the entanglement based protocols. The latter can also be used to perform quantum teleportation. These methods are differ in terms of security, possible key exchange rate and in other aspects which will be compared in the coming sections.

Finally, some of the recent advancements in satellite based QKD will be detailed with an outlook for future opportunities and how these technologies could shape our lives.

The research is connected to COST Action CA15220 Quantum Technologies in Space.

Keywords:
quantum key distribution, space communications, communication security

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Sentinel-1 PSI Analysis of Greater Budapest Region

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With more than three years of Synthetic Aperture Radar (SAR) observations since the launch of the first Sentinel satellite Sentinel-1A in April 2014, the Sentinel-1 tandem provides a reliable, constantly growing dataset for many applications. For interferometric uses - after the precise co-registration that is required due to the new scanning method Terrain Observation with Progressive Scanning (TOPS) - we can not only create interferograms but perform persistent scatterer (PS) analysis for long-term stability and deformation analysis as well.

Budapest, the capital of Hungary with a population of more than 1.5 million is situated in the selected area for this case study. It is expected to provide hundreds of thousands persistent scatterers with high amplitude, good phase stability and with many different scattering and movement characteristics. We also have extensive data available for the Kőbánya area where a large anomaly was detected and discussed by many previous studies. We use this area for validating our results with ground based high precision levelling surveys.

The processed data consist of 3 bursts of the same sub-swath. Multilooking is done by factors of 10 and 2 in azimuth and range directions, respectively. The persistent scatterer processing is entirely done by the Gamma software from Single Look Complex (SLC) data to displacement time series, using a single master approach. The dataset covers 2.5 years and consists of 50 descending images - the last one has already been acquired by the Sentinel-1B satellite. High coherence is expected between subsequent acquisitions due to the small temporal baseline of 12 days. This results in high PS density in urban areas and sparse coverage of rural areas where no agricultural activity is present. The main source of error is the atmosphere, as it is the largest unknown addition to the measured phase. Effective re-

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moval of this phase contribution is essential to reach the maximum potential of Sentinel deformation measurements.
In summary, we present our preliminary results of Sentinel PSInSAR applied to the mainly urban setting of Budapest area, inspect it in terms of quality and validate it with on-site measurements.

Keywords:
Sentinel-1, PSInSAR, Budapest, surface deformation

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Optical transfer in space communication

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In space communications the optical transmission (OT) has been applied for satellite - to - satellite link (SPOT-4 –OPALE, OICET) since the mid - 90s. This first inter – satellite optical communication link was a short distance, non-continuous operational transfer link between ARTEMIS - a geostationary earth orbit satellite (GEOS) for telecommunications – and SPOT-4 - an Earths observation low earth orbit (LEO) satellite. These inter satellite connection was a really high capacity data transfer link. In the earth observation systems, the large amount of data collected by observation equipment is transferred to an earth station through a repeater GEOS satellite.

The primary advantage of using optical transmission in space communications provides a high-security and high -speed link without the turbulence and other problems of Earth's atmosphere.

In case of long - distance space or deep space communication the channel should be powerful and of high security. In deep space transmission the information rate is very low because of high - latency links. This is why large bandwidth and virtually error - free transmission is required.

This paper presents the properties of free space optic (FSO) systems which used in long distance space communication in a satellite – to - spacecraft or in a satellite – to – satellite link. We discuss advantages and disadvantages of optical transmission in space communication, present the most significant problems during FSO link application and introduce techniques for drawback eliminations.

The paper details maximum available channel characteristics especially channel capacity, outage probability (Pout) and the value of bit error ratio (BER).

In our article we introduce that the use of multiple inputs and multiple output (MIMO) FSO system is the most appropriate in order to maximize date rate and channel capacity together with minimizing the transmission error and reduction the negative effect of correlation and interference. Unfortunately under special conditions in case of satellite - earth connection the use of optical links may become very vulnerable. The effect of scintillation, caused by the atmospheric turbulence degrades fatally the efficiency of the channel. That is why in certain cases an additional radio frequency link may be required by which negative effects of turbulence can be minimized.

We are introducing a multi - hop communication channel that ensures the high date - rate and high reliability, uninterrupted space link connection. We describe the conditions under which the optical link can be applied in satellite communication and in which case it is necessary to effectively modify or revise the optical connection.

Keywords: free space optical communication, diversity, correlation problems, hybrid RF/FSO

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Comparing Calculated and Measured Losses in QuESS's Quantum Channel

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Previous theoretical calculations and proof of concept experiments indicated that satellite quantum channels might have lower losses than conventional optic fiber channels. However, these predictions were largely untested up until recently. The Chinese QuESS satellite [1] was the first that realized a space-earth quantum downlink using ultra weak laser signals. This allows for distribution of entangled photons at a record long distance. These photons can be used for physics experiments as well as quantum key distribution. These applications require accurate predictions of channel loss.

To confirm the accuracy of theoretical predictions, we compared the calculated channel characteristics with the reported values. These characteristics involve the beam widening and the channel loss. Based on the reported parameters in the QuESS experiment we calculated the elevation angles from the point of view of the ground stations as well as the channel lengths. These calculations gave us the relative position of the satellite and the two ground stations when the channel loss was the highest and the lowest.

While calculating the channel loss, we took into account the atmospheric beam widening induced by optical turbulences. To model the optical turbulence strength we compared several approximations including the Huvnagel-Valey 5/7 model [2], the HV -Night model [2] and the Greenwood model [2]. The total beam widening (including long and short term beam spreading) was calculated using geometric optics approximation as well as the Huygens-Fresnel approximation [3, 4].

Extinction of the beam by atmospheric gases and aerosols was calculated using a semi-empirical approach based on measurements [5] that were performed under mid latitude summer con-

ditions. In our calculations we examined clear and hazy weather conditions as well. Our results show that most calculations yield results in the same order of magnitude as the measured values.

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Keywords:
Quantum Communication, Downlink, Channel Loss

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Simulation of different quantum error correction codes in free-space channels

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Quantum computing differs from classical computing in its core concepts. Instead of the well known bit which can have two discrete values one or zero, quantum bits (or qubits) are used. Qubits can be represented by a complex vector, which can take infinite number of values, as far as certain requirements are made [1].

Transmission of qubits from one point to another is error prone just like in the classical case, but qubits may have many different types of errors. For example, a bit can flip, get a phase error, get depolarized, participle carrying the quantum information can be lost etc. These may all affect any quantum operations afterwards for example the measurement used to convert back to classical information from qubits.

In the classical case, linear codes can be used to detect and correct errors on an error prone channel. Usage of these codes in quantum computing is not possible because a quantum bit cannot be cloned. Instead a quantum phenomenon is relied called entanglement. A multi qubit entangled states can be created from input qubit(s) and sent, at receiver side errors are corrected (if possible), and finally state is decoded.

In our work, a simulation has been made capable of testing usual quantum error correcting codes (Bit-flip code, Shor code, Steane code, 5 qubit code) [2,3] and a special 4 qubit code for amplitude damping channels [4], using common channel models like depolarizing or amplitude damping channel. The program runs in Linux terminal and supports multithreading. Every single transmission's measured ancilla bits and result are logged to standard output for further analysis. Channel information is read from a network descriptor file, this can be used to specify

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even a multi error channel or larger network of communication participants. Results suggest usage of 5 qubit code for depolarizing channel. If amplitude damping error is present, the codes used turned out to be worse than no coding or had little effect.

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Keywords:
quantum communication, error correction, free-space communications

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Preparing a Lunar Rover Mission in the Framework of Analog Planetary Research

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Testing of hardware in space analog environments is a powerful tool in space exploration. Analog Planetary Research (APR) is a relatively new and rapidly growing topic in this field: APR is about development of equipment, methodologies and strategies for future human and robotic planetary exploration [1],[2]. It involves studying mission planning, operational procedures as well as hardware testing (prototypes/engineering models) still on Earth, but under environmental conditions as similar as possible to that of the targeted planetary body.

The results of APR missions can be used to detect possible conceptual deficiencies, software and hardware bugs and other physical faults. These can be evaluated and fixed in an early stage of development, prior to launching the real mission. APR is not only a valuable tool for mission planning validation, but also a cost-effective testing opportunity for operational and hardware concepts.

Team Puli Space, a former official Google Lunar XPRIZE contestant, participated in various APR missions to test its mission planning and operational procedures as well as mission hardware prototypes and its Mission Control Software. These APR missions took place in various planetary-analog environments, such as a Mars analog field simulation in Morocco - MARS2013 [3) - , the PISCES testing site in Hawaii - Mission Maunacast -, and on Kaunertal Rock Glacier in Austria: Puli Rocks in the AMADEE-15 mission. Team Puli conducted and tested area selection, rover health check, mapping, and mission control procedures, and other tasks regarding the requirements of the GLXP contest and the planned lunar mission itself. Based on the re-

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sults of these APR missions, designing and building of Puli's space-grade lunar rover is currently underway.
This is a publication of Team Puli Space.

Keywords:
APR, field test, lunar mission, education

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Analyzing the Effects of Atmospheric Factors in Earth-space and Space-Earth Quantum Communication Channels

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So far 2017 had the most important milestones in satellite-based quantum communication as a video conference between Beijing and Vienna [1] has been held. That was not only a demonstration, but also a real proof of the feasibility of the space-based quantum data transmission. Basically, a satellite-based network is composed of at least one ground station and one satellite. Ground-space, space-ground and space-space channels are used to transmit data between the endpoints of the route in the network [2].This means the different properties of the Earth's atmosphere has been taken into account to determine the performance characteristics of an Earth-space or space-Earth optic channel. All of the atmospheric factors affect the transmittance of the channels and all of the analyzed quantum key distribution (QKD) protocols, including BB84, B92, S09, Gisin take into account the transmittance to determine the Quantum Bit Error Rate (QBER) of the protocol. Here appears the importance of the Earth's atmospheric factors in a quantum-based satellite network. In this paper, our goal is to analyze and evaluate the effects of the atmospheric factors in the mentioned communication channels.

In September of 2017, we have released the latest version of the Quantum Satellite Communication Simulator, which was developed directly to analyze satellite-based quantum communication channels by various scenarios, taking into account the atmospheric factors of the Earth. In this paper, we analyze the influences of absorption and scattering of the light beam in different climate, season and weather conditions.

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Keywords:
quantum communications, satellites communications, atmospheric factors

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Comparison of the predicted depressed state of crew members with the results of their subjective psychological test at Concordia research station

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In this study an automatic prediction method is presented which can predict the severity of the depression of the examined person based on the speech signal.

Several researchers work and live at the Concordia research station, which is located in Antarctica. We are participating in the "Psychological Status Monitoring by Computerized Analysis of Language phenomena (COALA-Phonetics)" project. One aim of this project is to monitor the psychological status of the researchers at the Concordia research station, especially to detect depression based on speech. Speech samples were collected from each crew members once a week. Two type of tasks were recorded: a short voice diary and reading out loud the standard phonetically balanced folk tale. Moreover, each crew member filled out a subjective psychological test, in less frequent intervals.

Speech data were collected from depressed patients and healthy subjects in normal atmospheric conditions as well, and this reference database was used to train the automatic prediction system based on Support Vector Regression (SVR). Beck depression inventory II (BDI-II) [1] was used to measure the severity of depression, and each speech sample, what was used for the training of SVR model, were labeled with this value. Our earlier regression results proofed that automatic prediction of depressed state can be carried out based on speech signal [2] Last year we have already tested how this developed regression model capable to detect the depressed state of some few crew members. [3].

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In this study we extended this depressed state analyzes on the full crew based on the earlier developed SVR model. The severity of depression of each record of each crew member of the Concordia research station was predicted using this automatic prediction method. The analysis of these time function of depression developing of crews were carried out and were compared with the results of the subjective psychological test (Positive and Negative Affect Schedule – PANAS) [4].

Keywords:
depression, SVR, speech processing, follow-up status monitoring, PANAS

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Recent trends in light pollution measured from space in Hungary

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There are growing interests in light pollution among scientific community (economic activity, health care, ecology, astronomy, air chemistry, meteorology). For mapping and monitoring the changes in light pollution one of the convenient ways is to measure the radiances from space. VIIRS sensor onboard the Suomi NPP satellite is capable to measure visual radiances (VIIRS Day/ Night band in 0.5-0.9 micrometer wavelength range).

Our attention is to detect changes in light pollution especially for those places in Hungary, where the public lighting system was replaced recently. Case studies and time series of Day/ Night band sensor data together with ground-based digital camera measurements are shown.

Keywords:
light pollution, sky brightness, remote sensing, VIIRS, Day/ Night band

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Simulations of Single Event Effects in microelectronics caused by the lunar surface radiation environment

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Ionizing radiation in space is hazardous not only for humans but for electronic systems as well due to Single Event Effects (SEE) often caused by even a single ionizing particle. Therefore, it is essential for space missions to know in advance the expected radiation environment as precisely as possible and design the electronics according to that. Since the lunar surface radiation environment is not known enough, we have performed Monte Carlo simulations using Geant4 [1] and Geant4 Radiation Analysis for Space (GRAS) [2] open-source codes to get flux spectra of secondary particles above lunar regolith induced by solar and galactic cosmic ray particles.

Based on our results, we have estimated SEE rates in microelectronics for a lunar surface mission on microscopic level using GRAS, as well as on phenomenological level using Cosmic Ray Effects on MicroElectronics (CREME) toolkit [3].

With a ^{60}Co gamma irradiation test of Commercial Off-The-Shelf microcontrollers at Institute for Nuclear Research in Debrecen, Hungary, we have already demonstrated that commercial microcontrollers are able to survive the Total Ionizing Dose effects of a Solar Energetic Particle event (solar flare) with at least a total dose of 35 kRad.

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Keywords:
lunar radiation, single event effect, simulation, irradiation test, microelectronics

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Opportunities of 3D printing in the emerging field of Space Chemistry

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Chemistry has been deeply involved in the design and synthesis of new materials for a wide range of purposes in space technology. As space opens new routes for chemistry, the worldwide network of academic experts, industry innovators and decision makers from the top pharma and other chemistry and life-science firms is constantly growing. The microgravity platforms developed for commercial use provide great opportunity to further research and technology activities in this emerging field.
Additive manufacturing or 3D printing enables us to design complex shapes tools. The 3D printed tools and objects provide new opportunities in the field of mechanical engineering, electrical engineering, and medicine among others. This special technology, which is already tested in space, can also play a key role in performing chemical synthesis in extreme environment.
In this talk a case study be presented, which will focus on the recent scientific developments in 3D printing and chemistry in space by summarizing the results and experiences of last years.
Our plans to use 3D printing for the development of a small-sized, mesofluidic reactor with robotic catalyst exchanger will be detailed at the end of the presentation. The reactor is intended to perform chemical reactions and nanoparticle formulations under microgravity environment.

Keywords:
Space Chemistry, microgravity, 3D printing, flow chemistry

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Assessment of GNSS positioning under extreme weather conditions for safety-of-life applications

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The emerging new civilian signals in the global navigation satellite systems (GNSS) help to mitigate the ionospheric effects in GNSS positioning with high accuracy due to its dependency on the frequency of the satellite signals. However, the neutral part of the atmosphere cause a systematic error on all of the satellite signals. Although GNSS is an all-weather positioning service, its performance depends on the weather conditions, especially on the water vapour content of the atmosphere.
Safety-of-life applications demand not only high accuracy but also the integrity of satellite signals. The Radiotechnical Commission for Aeronautics (RTCA) published some recommendations on the assessment of the performance of satellite navigation systems. They recommended to estimate the maximal standard deviation of the tropospheric delay on satellite signals to be 0.12 m in the zenith direction.
Real observations show that this value is too conservative for many regions of the world. Our paper studies how the various troposphere models perform under extreme weather conditions. In order to assess this, the mathematical tool of extreme value analysis is used on more than 16 years of global numerical weather model data.
Based on the analysis of these data sets, new models have been derived for the estimation of worst-case troposphere model performance for the safety-of-life applications. Our model takes into considerations not only the geographical, but also the seasonal variation of tropospheric effects and model performances. As a consequence, less conservative but reliable models have been derived for the integrity modelling of tropospheric delays. These models may contribute to a higher availability of satellite positioning services on airports, in autonomous vehicles, etc.

Keywords:
GNSS positioning, tropospheric effects, integrity, safety-of-life applications

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Monitoring the movement of geodetic network in Thailand during 2013-2017 by GNSS

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Nowadays Global navigation satellite system (GNSS) has developed to be able to accurately reach the millimeter level which is enough for monitor the movement of the plate tectonic [1]. Since the 2004 in Sumatra, 2005 in Nias and 2007 in Bengkulu, earthquakes caused displacement all over south-east Asian region [2]. Thailand located on sundaland block that was also significantly deformed during the earthquake at the cm. to dm. level[3]. The Thai geodetic network has effected directly by all earthquakes that direction to move to the epicenter[4]. The Royal Thai Survey Department (RTSD) is primarily responsible for monitoring of the crustal movement of the country and have total 19 geodatic network points and the geodetic network will continue to deform for many months and possibly even years to come [3]. So geodetic network should be re-measured every year for monitoring and that secure the accuracy of geodetic network of Thailand.

This research will process to fining magnitude and direction of all geodetic network points using the precise point positioning technique of the RTKLIB software by using precise satellite orbit and clock from Center for Orbit Determination in Europe (CODE) during 2013-2017. To enable an accurate mapping of coordinate result into International Terrestrial Reference Frame 2008 (ITRF2008) and was update coordinate of geodetic network in Thailand to be present.

Keywords:
Global navigation satellite system, Geodetic Network, precise point positioning

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Activity of the ESA National Technology Transfer Office: Space technologies in everyday life

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Hungary has become a new member of ESA (European Space Agency) technology transfer network which works throughout Europe on facilitating innovations, systems and know-how of space technology in non-space areas, thus also in everyday life. The membership enables our country to become a party to the activity of the largest European space organisation. The Hungarian participation will be realized by the Hungarian Space Board operating in the Ministry of National Development actively involving the Hungarian Academy of Sciences' Wigner Research Centre for Physics.

The new Hungarian membership has a beneficial impact on the economy and its players as well as in the everyday life, since the cooperation will affect dynamically developing areas like satellite navigation, telecommunications, meteorology, health care or environmental protection.

The European network consists of technology transfer brokers who can promote the international exchange of views and experiences based on their knowledge, networking and expert teams, further initiate new developments set up to utilise transferred space technology. The national technology transfer point has been opened in the Hungarian Academy of Sciences' Wigner Research Centre for Physics.

The cooperation aims to explore and support - even financially - as many initiatives and start-up projects as possible who can utilise international space research innovations and know-how in non-space areas. This way the network tries to further the international market launch of Hungarian enterprises, contribute to the economic growth of the country, strengthen their business results and generate to create new jobs and companies. The European Space Agency brings a successful technology transfer model to Hungary, providing international opportunity for Hungarian innovators.

Keywords: space, ESA, technology transfer

Sensors of Swarm Stream as Technology Research on Nano Scale

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The 21st century's technology gives us opportunities to rethink forward the nano scale technology using modern analytical methods for sensors and data collection, precomputing and transmitting to Earth in space technology. Author's earlier works described the Nano, Pico Space Devices and Robots (NPSDR), and Streaming Swarms [1] which type devices maybe can fulfil the requirements.

Let we think about some in situ combined measuring possibility deployable on a streaming swarm. The swarm contains mainly similar devices, but the functions can be different. Let we see here a remote sensing and an in situ measuring possibility. Technology allows to make small full spectrum scanner to put on an element of Streaming Swarm. [2] Using a telescopic lens system before the CCD it can collect data from a remote surface. Changing the lens it can became an in situ spectrum analyzer as optical, non-invasive sensor, to measure the collected in situ available matter. We can add into a flat hexagonal measuring field another two detectors in pair on the opposite sides. A piezo electric variable frequency (chirping) matter (dust) detector which mainly non-invasive and last an ultimately usable chirping capacitor type detector which method can became invasive in point of view of the collected matter.

Full spectrum field scanner for detecting and recording full spectrum can produce a data which can be processed in real time and/or post-production data to examine a field or serials of fields of space and surfaces. The technology is a spectrum maker (prism or spectrum diffractometer), a recorder (CCD, EHD camera and recording facility, e.g. similar to be used on android system), a pre-processor facility to earn quick results and a detailed post-processor facility to reanalyze the full data. The CCD is wide range CCD from 1400nm-220nm (or min 800nm-330nm) multi-layered (BGR), multi-read WDR, Shutter Reset. Recording is minimum 60fps, resolution is minimum 20 Mpixel

to 80Mpixel. Prism is a small line of prism from optical glass or optical grid to generate spectrum is a small grid to generate a refracted continuous clean spectrum. Data recording must be continuous lossless recording from 20-80Mpixel camera in ideal case; shorter but lossless data recording above a specified smaller field.

Streaming swarms gives possibilities to collect data from big fields and space in one time. The whole streaming fleet necessary to behave like one big organization. The redundancy coming from the large amount of abundance of the Streaming Swarm with Sensors.

Keywords:
stream swarm sensor nanoscale

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Participating in NASA-ESA Cassini Mission at Wigner RCP, former KFKI RMKI

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The Cassini mission was the biggest and longest International space mission until now. The developing of the NASA - ESA common mission has started in 1991, the launch was in 1997 and the space probe have arrived to Saturn in 2004. Since that year it had been measured on orbit and the mission ended in 15th of September of 2017.

Cassini had 12 experiments on the board. Our engineering participation was in CAPS (Cassini Plasma Spectrometer) and MAG (Magnetometer). Our engineers participated in developing of EGSEs (Electrical Ground Supported Experiments) for both experiments.

CAPS includes an ion mass spectrometer (IMS) providing species -resolved measurements of the flux of positive atomic and molecular ions as a function of energy/charge vs. aperture entry direction; an ion beam spectrometer (IBS) that measures the flux of positive ions of all species as a function of energy/charge and entry direction; and also an electron spectrometer (ELS) to measure the flux of electrons as a function of energy/charge and entry direction. [1] MAG, which a Dual Technique Magnetometer is a direct sensing Instrument that measures the strength and direction of the magnetic fields around Saturn. The magnetic fields are generated partly by the intensely hot molten core at Saturn's center. Measuring the magnetic field is one of the ways to probe the core, even though it is far too hot and deep for an actual visit. Magnetometers are direct sensing instruments that detect and measure the strength of magnetic fields in the vicinity of the spacecraft. MAG consists of a vector/scalar helium magnetometer sensor, a flux-gate magnetometer sensor, a data

* corresponding author

processing unit, and three power supplies, plus operating software and electronics associated with the sensors. [2]

Several identical circuits were designed during the rest of developing of EGSE e.g. TASS and Mil1553 boards. TASS is a PC card named as Temperature Acquisition Subsystem Simulator for Eight Channels. TASS can measure eight platinum temperature sensors. It is developed according to the requirements of the Cassini experiment. Mil1553 boards were used to communicate and test in communications between electrical circuits of experiments.

Our physicist connected to the analysis of the results of the experiments and have several results they published, e.g. the exploration of the variable plasma environment of Titan, to investigate the similarities and differences between the processes that lead to the induced magnetospheres around Titan and around similar non-magnetic bodies; and to identify the major physical clues of those processes.

Keywords:
Cassini, Saturn, Titan, Plasma, Magnetosphere, NASA, ESA, Wigner, RMKI

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Tomographic Reconstruction of Atmospheric Water Vapour Using Simulated GNSS Data in Hungary

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Water vapor is an important ingredient of the atmosphere. As part of the hydrological cycle and as an important greenhouse gas, it plays an important role in weather forecasting and the study of the climate change.

The traditional methods for measuring the atmospheric water vapor (e.g. radiosonde) can not get a good temporal and spatial resolution due to the costs of the instruments and the ground infrastructure. However the Global Navigation Satellite System (GNSS) can supply stable all-weather and all-day ranging observations to the satellites. GNSS observations are affected by the atmospheric water vapour, causing a delay in signal reception. Thus these observations could theoretically be used to reconstruct the 3 dimensional distribution of tropospheric water vapor.

To create such 3D water vapour fields, a tomographic approach is developed for the processing of slant topographic delays derived from the observations of the Hungarian active GNSS network using the algebraic reconstruction technique (ART). The methodology has been tested in a two-week-period in the territory of Hungary and the results are compared with the actual numerical weather models for validation purposes.

The results showed that the tomographic reconstruction of atmospheric water vapour is feasible, but an important limiting factor of the spatial resolution of the model is the number of available ground based GNSS stations.

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Keywords:
water vapor, tomography, GNSS

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EDUCATION AND OUTREACH

Filling the Gap in the ESA Space Technology Education

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The CanSat project is an excellent program for young people below the age of 20 years. It serves as a strong motivation and directs their interest to the world of real satellites, principally to continue their studies in space technology and doing research in the area at university level. At Budapest University of Technology and Economics (BUTE), we are involved in the education of future engineers. After the the next level in satellite construction following the CanSat is far too high to produce a continuous education process.

The price level for a CanSat is approx. 200 Euros. As the next technological step, the ESA recommendation is the 1U cubesat (10 cm cube) with its 100k Euro price. For university teams it is necessary to have a continuous sponsorship during the whole cubesat development as a real challenge. Our aim is to fill this gap in the ESA education program by the construction of a 1-PocketQube satellite (5 cm cube).

The price of this satellite level is quarter the price of the 1U, however the realization is still a real challenge for the students. The two-level launch possibility of the VEGA carrier provides a 6 -8 month lifetime which also ensure a limitation in the increase of space debris. In most cases, this time is enough to carry out new measurements, like the experiment of SMOG-1 satellite. For comparison, the USA has the ThinSat project with its 5-10 days of lifetime and costs 18k USD including the launch prices.

In the full paper, we will introduce the satellite development at BUTE, including the first Hungarian satellite called Masat-1, the potentially second Hungarian student satellite called SMOG-1 and our CanSat project.

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Keywords:
Masat-1 cubesat, SMOG-1 PocketQube, CanSat

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Fifteen years in service for the society – the story of the Hungarian space web portal Űrvilág

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The popular Hungarian astronautical web portal Űrvilág (i.e. Space World, [1]) was established more than 15 years ago, in late 2002. It is maintained by a small group of experts, students and space enthusiasts on a non-profit basis, making use of the advantages of on-line publication. The access to our articles has always been free for any reader, and we encourage other media to use our materials for their news items provided that the original source is properly acknowledged. We offer at least one new space-related article every day, covering major international and national space news in Hungarian language. We are also keen on presenting cases of various space applications and spin-offs. The Űrvilág web portal is available for the Hungarian space research community and space industry as a means for popularizing their own results and achievements. Our complete full-text article data base, nearly 8000 items published since 2002, is available on-line. With its comprehensive and reliable coverage of space topics, the Űrvilág portal generated a stable reader base and is highly recognised in professional circles in Hungary.

In this paper, we describe our motivations and the aims of this endeavour, and the operational background of the Űrvilág web portal. We also and present some highlights of its history spanning more than 15 years.

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Keywords:
popularization, outreach, web portal, space news,
space applications

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Expanding the Space of Space learning

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The importance of having the same education program around the world is not prosaic. A multispeed space race, in which the influence of Member States varies, could have weakened proficiency related to a common space science standard. It is clear how important a common level of learning is within the Space sector, especially given the use of it to assure national development and peaceful uses. For that reason, during the UNISPACE 1968, State delegates endorsed creation of a specific space science programme and just like that, United Space Programme on Space Application was adopted providing training courses and long-term fellowship opportunities under institution cooperation's.

In support of this initiative, United Nation General Assembly adopted resolutions 45/72 and 50/27, conscious of the need to increase growth of space technologies and benefits derived therefrom. These decisions are especially important to progress of education systems for the sake of greater legal certainty – taking particular account of the interest of development countries. International effort to establish *Regional Centre for Space Science and Technology Education*, affiliated to the United Nations, have been realized with the aim to get higher and immediate results to promote a cross border educational activity.

Based on a specific assessment process, a UN commission of experts has identified the following nations that would hosted Regional Centers: India (1995), Morocco (1998), Nigeria (1998), Mexico and Brazil (2003), Jordan (2012) and finally China in 2014. Furthermore, in order to have a common level of learning in the Space sector it is important to start from formal education in the school. In our knowledge-based society many studies ha-

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ve highlighted an alarming decline in young people's interest for key science studies and mathematics. The international science education community mostly agrees on the importance to adopt pedagogical practices on inquiry-based methods are more effective to reverse this trend. A motivating context for teaching and learning STEM is important to engage students in their study and to pursue a career in these fields, in the space domain in particular . In this sense space science is a very good context for learning STEM and a useful tool to help attract the interest of students. Space is able to turn on the imagination and promotes curiosity.

Keywords:
education program, space sector, common standard, knowledge-based society

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Solar Physics in the high school – Study of the sunspots

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The students are amazed at the Sun and them looking forward to the processes that are taking place there. It is a serious challenge for a teacher to present and make understandable the solar physics phenomena for the young students, but it is also very important. The telescopic observations, astrophysical and astronomical presentations, astrophotography help to recognize phenomena, but there is also an opportunity for thorough learning during the classroom activities.

The Sunspots are very interesting dark and cool areas on the Sun, which could be observed with telescopes. In the secondary school, we can make a direct observation but for the classroom activities, we use the SOHO database and the "Debrecen Photoheliographic Data". From these databases, we download 10-12 images of the Sun taken by the SOHO satellite during a few days on specified time. For each picture, the students will calculate the coordinates (longitude and latitude) of the sunspots using a grid map and trigonometry. From the collected data, they will determine the differential rotation of the Sun. For best results, the upper secondary level students use the Aladin software and they animate the movement of the sunspots. During the classroom activities, students will also be able to answer some questions about space weather and its impact on the satellites and terrestrial phenomena.

Keywords:
education, sunspot, space weather, Aladin software,

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ESERO Romania:
Using Space as a Gateway to STEM

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How can you make STEM exciting to kids? By engaging them in exciting hands-on, minds-on (and eyes-on!) activities, by training their teachers in exciting subjects, and by providing them with exciting classroom materials. ESERO Romania (The European Space Education Resource Office - Romania) has been established in 2014 as a collaboration between the European Space Agency and the Romanian Space Agency. The key aim of ESERO Romania is to increase STEM literacy in Romania by using space as an appealing context to make the teaching and learning of Science, Technology, Engineering and Math subjects more attractive and accessible. In Romania, the Office aims to bridge the gap between the prize-winning elites and the scientifically illiterate mass through the training of teachers, through raising awareness of space activities and through the dissemination of materials, making full use of ESA's literature and logistical support in this process. The Romanian ESERO is also serving as the main interface between ESA Education and the Romanian educational community. The ultimate aim is to assure the formation of a future work force active in the space and engineering fields.

Keywords:
STEM, Space education, Education

Citizen Science – An idea to integrate science into our digitized world

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While the transmission of the information is getting more and more accelerated nowadays,we should thinking "out of the box" about the biggest milestones of the scienctific era,to rate and explain and go more further in every aspect of the present and future of our lives, including the space research as the tomorrow's biggest challenge of the mankind.

While we getting more and more theoretical and practical experience about our environment up and below the horizon, we should spread the knowledge for everyone who feel enough motivation to help our mission to explore our planet in various ways or be adventurous to discover unknown depth of the void between the stars and planets far away. We should start a long-term project, controlled and supported by the local schools and universities as resource centers for everyone, who wants to take part in it,to help the science in every way, as an innovative and creative citizen. To help this task we should make DIY small kits to which are contains quite cheap and easily available parts to assemble by everyone without age or exact qualification limit or global location to reproduce or observe the experiments in real time even at home.

The results what we get from these actions makes the sampling spectrum more wider and diversed for the sciencists. With the help of the volunteer civilians we can organize smaller research groups to methodize these amount of data, remain in contact with the main institute's experts, manage workshops while they supervise, operate with the apported assembling kits. It allows to the smaller, and almost unreachable areas to join to an international project what was impossible before and make theim new possibilites to catch up with the another parts of the globe.

These movements in the future maybe let us to make a "KISS"-like cubesat constellation which can be very important and life-saving option in a global emergency situation-like the latest hurricane events, when all the communication channels were blocked or destroyed by the heavy storm -from any location from the Earth we can use it as a standby communication channel to help the work of the aid organisations and the lifeguards in the devastated zones.

Hungarian Astro Pi experiments on the ISS

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The First European Astro Pi mission was launched by ESA and The Raspberry Pi Foundation in 2016 [1]. Teams of students from all ESA member states could join the competition to design and code their space experiments that could be selected to run on the ISS. The codes had to be written in python and had to match the mission rules, so they could be executed on the Astro Pi computers already placed on the station.

We were the only Hungarian team whose code was selected to run on the ISS. Our main goal was to find the weakest points of the Earth's magnetic field. We did this by collecting magnetometer readings along with latitude and longitude information of the space station. The data was returned to the ground and visualized on a geochart. The chart shows the 100 weakest points in the Earth's magnetic field. It should be noted though, that we only had 3 hours to collect the data. This means, that our data covers only two orbits, which is a very narrow path. Our results can be seen on our website [2].

This year the second Astro Pi Mission was announced [1]. We submitted our idea to this year's competition. Right now, we are in the second phase of the mission. This means we are selected to write our code, what will be evaluated and possibly selected to be sent to space. This year we are planning on measuring the light pollution over Europe with the Astro Pi's Infrared camera, the use of which was prohibited last year. Our main goal is to see whether we can distinguish dark sky protection areas like the "Zselic Park of Stars International Dark Sky Park" [3] and the "Møn and Nyord International Dark Sky Community" [4]. We will also try to visualize the color difference between the new LED lights and the old incandescent on a color diagram.

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The real way to teach students is to show them how to learn. The Astro Pi Mission gives a great opportunity for students to learn about space and the importance of coding and logic at the same time. It makes students solve their own problems and answer their own questions. Therefore, combines the greatest of skills needed in real life.

Keywords:
education, Astro Pi, space experiments, research-based teaching, space generation

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H-SPACE 2019

The 1st International Conference on Research, Technology and Education of Space was the opening event of the conference series. It was held on February 13, 2015.

The 2nd International Conference on Research, Technology and Education of Space was held on February 25-26, 2016.

The 3rd International Conference on Research, Technology and Education of Space' was held on February 9-10, 2017.

The 4th International Conference on Research, Technology and Education of Space' was held on February 15-16, 2018.

H-SPACE 2019, the 5th International Conference on Research, Technology and Education of Space' is planned to be organized in February, 2019 in Budapest, Hungary.

The Call for Papers will be available from September 1, 2018 on the http://space.bme.hu website.